Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

NOTES AND LITERATURE

THE COAL MEASURES AMPHIBIA OF NORTH AMERICA[1]

THE excellent monograph by Dr. Roy L. Moodie is a worthy successor of the long series of works by Dawson and by Cope on the air-breathing vertebrates of the Coal Period in North America. The extremely varied amphibian fauna of the coal swamps as described by Moodie contains representatives of no less than 7 orders, 19 families, 46 genera and 88 species, the animals ranging in size from the minute *Eumicrerpeton,* less than two inches long, to the great *Leptophractus obsoletus,* which was as large as an adult Florida alligator. The wide differentiation and high specialization of these amphibians shows that the class even at that early epoch had evolved very far from its first adaptive radiation, so that, as Dr. Moodie well observes, the origin of land vertebrates from fishes must be looked for in a much earlier time, perhaps the Silurian.

Carboniferous Amphibia are reported from various localities in North America, but only four of these have yielded large or important collections. From the South Joggins coal mines in Nova Scotia Sir William Dawson secured most of the specimens of Microsaurs described by him, many of the skeletons being found in the rotten stumps of *Sigillaria* trees. This material is preserved chiefly in the Museum at McGill University, Montreal. From the Linton, Ohio, coal seams Newberry and his collectors secured the great collections described by Cope and which are now chiefly in the American Museum of Natural History. At Mazon Creek, Illinois, the fossils are found in ironstone nodules in a stratum of shale; the specimens have been described chiefly by Newberry, Cope and Moodie and are scattered in various museums. At Cannelton, Pennsylvania, the fossils occur in slates and have been described by Moodie, the material being in the National Museum.

On account of the fragmentary nature of most of the material and the fact that generic and specific names have been based on many different and non-comparable parts of these animals, the author's task was an exceedingly difficult one, and only those who have occasion to study this work very closely can appreciate either the magnitude of the undertaking or the thoroughness with which it has been carried out.

---

[1] Carnegie Institution of Washington, Publication No. 238, 1916.

Dr. Moodie's monograph will naturally invite comparison with the well-known works on the Permian Amphibia of Bohemia and Saxony by Fritsch and by Credner. It must be admitted, however, that many of the illustrations are inferior to those of the works mentioned, partly on account of the difficulty of showing the real character of these fragmentary specimens by means of photographs.

The author's method is so intensive that he has left even readers who may have some first-hand knowledge of Paleozoic Amphibia in need of many broader facts and comparisons which may reasonably be expected to result from such a conscientiously executed investigation; it is the aim of this review in some measure to supply this deficiency, in the hope that Dr. Moodie himself may be induced to write a general article covering more fully the points here raised.

In the chapter on stratigraphic and geographic distribution the author shows that the four chief Amphibia-bearing formations in North America mentioned above are all in the Alleghany or Lower Coal Measures and are thus much older than those deposits (Salt Fork, Pitcairn) of the Upper Productive Coal Measures at the top of the Pennsylvanian series, which have collectively yielded *Cricotus, Diplocaulus, Eryops* and other genera characteristic of the Texas "Permian."

The author does not discuss the faunistic relations of the Lower Coal Measures fauna either with the "Permian" fauna of Texas and other states, or with the Carboniferous and Permian faunas of Ireland, Scotland, England, France, Saxony and Bohemia. Even the Permian and Triassic amphibian faunas of South Africa invite comparison with the varied Temnospondyli of the Carboniferous and Permian of America and Europe.

The Lower Coal Measures fauna of America includes a long series of branchiosaurs, microsaurs and primitive labyrinthodonts (*Spondylerpeton, Dendrepeton, Macrerpeton, Eobaphetes*), and it is totally lacking in pelycosaurs, poliosaurs, cotylosaurs, or any other reptiles except *Eosauravus*. The Texas fauna, on the other hand, has only a single microsaur (*Crossotelos*) and no branchiosaurs; its varied labyrinthodonts (including *Cricotus, Eryops, Dissorophus* and many others) are all genera not found in the Lower Coal Measures, and it abounds in reptiles of several orders and many families. Some of this difference may be due to the fact that the Lower Coal Measures fauna represents only the life of the coal swamps, while the Texas fauna represents the life of the pools and streams of a wide delta country (Case); but all authorities agree that the former is much the older of the two.

The Lower Coal Measures fauna is far more similar to the Permian fauna of Bohemia, which according to Fritsch's classification comprises a similar series of 13 families, 26 genera and 63 species, of branchiosaurs, microsaurs and temnospondyls. But no genera are common to the two countries and many of the "families" (as listed) are peculiar to one or the other. The families peculiar to America are the Cocyctinidæ, Peleontidæ, Tutidanidæ, Ptyoniidæ, Molgophiidæ, Sauropleuridæ, Amphibamidæ, Ichthycanthidæ, Stegopidæ, Macrepetidæ, while those peculiar to Europe are the Apateonidæ, Limnerpetidæ, Microbrachidæ, *Dolichosoma, Ophiderpeton,* Melosauridæ and Archegosauridæ. The families common to both continents are: Branchiosauridæ, Diplocaulidæ,[2] Hylonomidæ, Urocordylidæ, Nyraniidæ,[3] Cricotidæ (Diplovertebridæ), Anthracosauridæ, Mastodonsauridæ.

Professor Case has directed attention[4] to the marked resemblance of two of the genera (*Diplovertebron, Macromerion*) from the lowest Bohemian horizon (Nyran) to *Cricotus* of the Upper Coal Measures of North America, as furnishing evidence that the Bohemian deposits are of Upper Carboniferous age.

Subsequent research may well show on the one hand that some of the American "families" are more closely related to European groups than is now recognized and on the other hand that some of the "families" classed as common to both continents are artificial or ill defined (Hylonomidæ?, Nyraniidæ?); yet even with our present imperfect knowledge it appears that the Lower Coal Measures fauna of America and the "Permian" fauna of Europe represent nearly identical life conditions and similar adaptations on the part of two divergent associations derived from some older and common source, possibly of Mississippian age and of wide distribution; and it further appears probable that the American Lower Coal Measures fauna is somewhat the older of the two.

---

[2] *Brachyderpeton* of the English Coal Measures, as shown by Watson, appears to be related to *Diplocaulus*.

[3] The presence of this family in America is doubtful, and Dr. Moodie's reasons for assigning the genera *Ichthyerpeton* and *Cercariomorphus* to this family are not stated and difficult to infer.

[4] *Science*, Vol. 42 (Dec. 3, 1915), pp. 797–798.

The chapter on the morphology of the Coal Measures Amphibia contains a careful description of the characters of the skull and other parts of the skeleton, but the author is extremely chary of generalizations. He might have mentioned, for instance, the interesting fact that the skull-pattern of these amphibians is a shifting mosaic, one in which several of the dermal elements have different contacts and different positions in the various families. In some microsaurs, for example, the postorbital grows backward and secures a broad contact with the tabular; in others it retains its primitive position. The jugal and lacrymal also differ widely in their form and contacts. The nasals and adjacent elements are small and much crowded in many branchiosaurs and microsaurs, long and wide in most labyrinthodonts. Certain dermal elements are present in some and absent in others, especially the intertemporal and the rare interfrontal and internasal elements. The shape of the occiput differs widely, sometimes truncate posteriorly, with the auditory notch obsolete, sometimes angulate posteriorly, retaining the primitively wide auditory notch. Very curious is the tendency of the different families of microsaurs to develop "horns"—sharp backwardly projected apophyses in the occipital region—growing sometimes from the tabular, sometimes from the squamosal and sometimes from both at once. These remind one of the backwardly directed processes from the "epiotic" and supraoccipital in the skull of teleost fishes and perhaps they may have served for the attachment of longitudinal ligaments or muscles in wriggling, aquatic types.

All the differences in skull pattern may be regarded as minor readjustments which were taking place after the more profound transformation of a generalized pro-ganoid skull into the amphibian type, the greatest alteration including the loss of the opercular bones so as to leave the gill chamber covered only by membrane and the change of the preoperculars or cheek plates into the squamosals. The author expresses the opinion that the membrane bones may have originally been derived from scales "which later became consolidated into large bony scutes," but on histological grounds the reviewer regards it as far more probable that in the ancestral fishes each membrane bone and each scale grew from clusters of cosmine tubercles underlain by tracts of vascular and stratified bony tissue, and that there never was a time when the elements of the dermo-cranium were scale-like in form (*i. e.,* rhombic or polygonal), although the several tissues involved were histologically identical in the body scales and in the dermo-cranium.

On page 85 the author uses the name "squamosal" for the element which he and most other authorities now designate as "supratemporal."

In the description of the hyobranchial elements of *Coccytinus* (a genus doubtfully assigned to the Proteida), the reader looks in vain for a comparison with the same elements in the Permian "Urodele" *Lysorophus* as described by Williston. It may be noted, by the way, that the branchial arches in that genus are extremely primitive and almost *Polypterus*-like in form and arrangement, although doubtless homologous also with those of the modern *Amblystoma.*

The author has given a very thorough study of the dermal scales and scutes of the branchiosaurs, microsaurs and temnospondyls. The ventral "scutellæ," which appear to be homologous with the abdominal ribs of reptiles, are formed, the author holds, as ossifications in the connective-tissue septa or myocomata of the ventral muscles, vestiges of these having been found in modern urodeles. The highly differentiated characteristics of this ventral armature affords many family and generic characters; it is sometimes absent or reduced to needle-like ossicles, sometimes highly developed, forming heavy median V's and wide lateral shelves (*Ctenerpeton*). Some of the microsaurs had rounded, slightly imbricating fish-like body scales with concentric markings which recall the similar armature of certain Bohemian and Saxon types, such as *Ricnodon* and *Discosaurus.* Vestiges of such conditions may be represented in the scales of modern cæcilians (as shown in the enlarged figures of cæcilian scales by the Sarasin brothers).

The reviewer ventures to doubt the correctness of Dr. Moodie's reconstruction of the shoulder-girdle of branchiosaurs and microsaurs, in the matter of the position of the scapula. Many of the specimens figured by Fritsch and by Credner seem to indicate that the concave border of the scapula was posterior in position, as it is in *Eryops* and in modern urodeles, and that it did not form the glenoid border as in Dr. Moodie's reconstructions.

Dr. Moodie's history of the classification of the Amphibia appears to the reviewer to be rather meager, since he simply lists the classifications of his predecessors without giving any critical discussion. It is surprising that in this chapter he did not mention the work of Fritsch with which he must be extremely familiar. Fritsch's classification of the extinct Amphibia, although it was adapted and extended from the classification proposed by the British Association Committee in 1870, was, in the judgment of the reviewer, a distinct contribution to the subject which certainly deserves notice in an historical review, especially since Fritsch erected several new families and gave definitions of all the European groups.

The author's own classification is an interesting attempt to divide the Amphibia of the Coal Measures into two major series or subclasses, the first (Euamphibia) including all those which may be related to modern types; the second comprising all the wholly extinct groups (microsaurs, aistopods and labyrinthodonts of all suborders). He derives most of the modern urodeles (Caudata) from the branchiosaurs, for which he has given considerable evidence; he follows Cope in provisionally deriving the modern Proteida from the Coccytinidæ of the Coal Measures. He regards the strange *Diplocaulus,* an amphibian with a head like a colonial cocked hat, as a member of the Euamphibia, probably because its vertebræ bear short, straight, double-headed ribs which are attached to paired lateral apophyses springing from the middle of the vertebræ, after the fashion of those of branchiosaurs and Caudata and quite unlike the hour-glass centra of microsaurs, which bear long, slender ribs between the vertebræ. But Watson and Williston regard *Diplocaulus* and *Brachyderpeton* as microsaurs, the last named genus showing in the vertebræ and in the skull how the *Diplocaulus* type may have been derived from primitive microsaurian conditions. Indeed it may well be argued that the branchiosaurs and urodeles (Caudata) themselves, in spite of the retention of gills in the young, may have been derived from primitive microsaurs, that is that the vertebræ and ribs of microsaurs are on the whole much more primitive than those of branchiosaurs and Caudata.

The systematic relations and origin of the frogs and toads remain doubtful. Dr. Moodie gives an excellent discussion of the resemblances of *Pelion lyelli* Wyman, from the Linton, Ohio, Coal Measures, to the modern Anura but leaves the phylogenetic problem open. *Pelion* is so little known that it may or not be ancestral to the Anura, and the Jurassic Anura are so entirely modernized that they do not bridge over the wide structural gap between the Paleozoic Amphibia and the modern frogs and toads. It seems to the reviewer, after repeated comparisons of the osteology of the Anura with that of many of the temnospondyls, that some members of the latter group, in the brain-case, the dermo-cranium and even in the vertebræ and limbs retain many characters which may reasonably be looked for in Paleozoic ancestors of the frogs and toads; and that such forms as *Brachyops, Cacops* and *Dissorophus,* although not directly ancestral, differ from the Anura chiefly in the retention of many primitive amphibian characters. It may be that some of the short-headed Triassic temnospondyls of South Africa will furnish the linking forms; but at any rate it is interesting to note that the existing frogs and toads retain a long series of characters in the skull and skeleton which are seen in the Paleozoic temnospondyls, and that they differ from the latter in such modernized characters as the following: the wide fenestration of the occiput and palate, the resulting slenderness of the skull bones, the loss of the dermo-supraoccipitals, tabulars, ectopterygoids, pre- and post-frontals, the completion of the auditory ring, the development of extreme saltatorial adaptations in the skeleton, including the modification of the vertebræ from the rhachitomous into the notocentrous and epichordal types, the development of a long continuous urostyle coincident with the forward shifting of the sacrum and lengthening of the ilium.

Dr. Moodie's arrangement and sequence of the families of microsaurs appear to the reviewer to be highly confusing. It would perhaps have been better, after beginning with the newt-like types, to pass at once to the long-bodied Urocordylidæ and the snake-like Molgophiidæ and Ptyoniidæ, instead of interjecting in the middle of the series the Stegopidæ, which appear to the reviewer to be more nearly allied with the Temnospondyli, and the Amphibamidæ, which are heavy-limbed offshoots of the primitive microsaurs.

The author's ordinal and family definitions are extremely full, but the reader will find so many characters that are common to several families and sometimes orders, that it is difficult to cull out the most striking ones. This the reviewer has attempted to do in the subjoined table in which he has also included the principal European families of branchiosaurs and microsaurs. The families of microsaurs are arranged so far as possible in the general order of their specialization, proceeding from the more primitive newt-like forms to the snake-like microsaurs or Aistopoda.

SYNOPSIS OF THE PRINCIPAL BRANCHIOSAURS AND MICROSAURS OF AMERICA AND EUROPE

A. Vertebræ phyllospondylous, *i. e.*, having the notochord expanded in the middle of each vertebra; transverse process in dorsal region large; ribs short, straight and heavy and borne on the transverse processes, usually near the middle of the vertebræ. Skull broad, obtusely rounded.
  B. Auditory notch posterior rather than lateral in position. *Branchiosauridæ*.
  BB. Auditory notch extended laterally, the squamosals lying far forward .... *Apateonidæ*.[5]
AA. Vertebræ lepospondylous, *i. e.*, with the centra forming gently constricted cylinders; ribs intercentral, typically long and curved.
  B. Digits (when present) 4 in manus, 5 in pes; carpus and tarsus cartilaginous.
    C. Body newt-like.
      D. Body covered with cycloid scales or sculptured scutes. Hind limbs longer than fore limbs.
        E. Skull narrow .... *Hylonomidæ*.
        EE. Skull broad.
          F. Ribs short, slightly curved. *Limnerpetidæ*.[5]
          FF. Ribs thin, curved ...... *Microbrachidæ*.[5]
      DD. Body-scales reduced or absent; neural and hæmal spines of caudal vertebræ often expanded.
        E. Ventral scutellæ absent, tail moderate in length, skull without "horns." *Tutidanidæ*.
        EE. Ventral scutellæ weak or moderately developed, tail long.
          F. "Horns" on squamosals. *Diceratosaurus*.
          FF. "Horns" on tabulars. *Urocordylidæ*.
            Brachiderpeton.[6]
            Keraterpeton.[6]
        EEE. Ventral armature highly developed, consisting of rods, plates or stout bristles. Skull (so far as known) without "horns." Ribs broad and heavy. Limbs well developed with claw-like phalanges .... *Sauropleuridæ*.
          F. Skull very wide and obtuse; teeth heterodont .... *Saurerpeton*.

---

[5] Permian of Europe.

[6] Europe.

FF. Skull moderately elongate; teeth homodont.
Sauropleura.

FFF. Skull very large; teeth with acute compressed apex and anterior cutting edge.
Leptophractus.

FFFF. Skull unknown; abdominal ribs very heavy with broad shelf-like lateral extensions; spines of vertebræ pectinate as in *Urocordylus, Œstocephalus* and *Ptyonius.*
Ctenerpeton.

CC. Body *Proteus*-like (serpentine). Limbs much reduced or absent ....(*Aistopoda*).

D. Ventral armature weak or absent.

E. Ribs long, heavy and broad; neural and hæmal spines short or absent ....*Molgophiidæ.*

EE. Ribs delicate, single-headed; neural arches wide with low spines. Skull narrow, pointed.
Dolichosoma.[7]

EEE. Ribs well developed; neural and hæmal spines of caudals expanded, pectinated; skull lanceolate with long, slender teeth ...*Ptyoniidæ.*

DD. Ventral armature consisting of narrow, oat-shaped scutellæ; ribs forked, two-headed; neural arches with low spines, lower transverse process expanded into a wide plate in the anterior half of the vertebra. Skull shorter and blunter than in *Dolichosoma.*
Ophiderpeton.[7]

CCC. Body stout; limbs well developed (but still with cartillaginous carpus and tarsus). Tail short, head very large. Ribs long.

D. No ''horns'' on squamosal, skin covered with rounded or hexagonal tuberculated scales. Ventral scutellæ present ....*Amphibamidæ.*

DD. Squamosals produced into ''horns.'' Ventral scutellæ apparently similar to those of *Amphibamus.*
Eoserpeton tenuicorne.[8]

BB. Digits of manus unknown; pes with well ossified tarsus. (Limb suggests *Erypos*). Ventral scutellæ delicate. Centra amphicœlous, spines broad and heavy ....*Ichthycanthidæ.*

AAA. Vertebral centra discoidal.

B. Vertebræ short, thick and probably amphicœlous. Body covered with small cycloid scales ....''*Nyraniidæ*''(?).[9]

C. Body newt-like ....*Ichthyerpeton bradleyi.*
Cercariomorphus.

---

[7] Europe.

[8] Placed by Dr. Moodie in the Urocordylidæ, but possibly related to *Amphibamus.*

[9] The skull of *Nyrania* as figured by Fritsch (Vol. II, p. 34) appears to the reviewer to relate this genius with the Temnospondyli; but it is placed provisionally by Dr. Moodie in the Microsauria.

CC. Body *Proteus*-like .... *Ichthyerpeton squamosum.*

BB. Vertebræ checker-like, deeply amphicœlous. .*Eosaurus.*

AAAA. Vertebræ unknown. Skull of pretty generalized type with separate intertemporal. Lacrymal and nasals large, orbits central rather than anterior; squamosals produced into short, divaricate "horns." .... *Stegopidæ.* (*Stegops*).[10]

---

[10] May be remotely related to the Temnospondyli (W. K. G.).

WM. K. GREGORY

AMERICAN MUSEUM OF
NATURAL HISTORY